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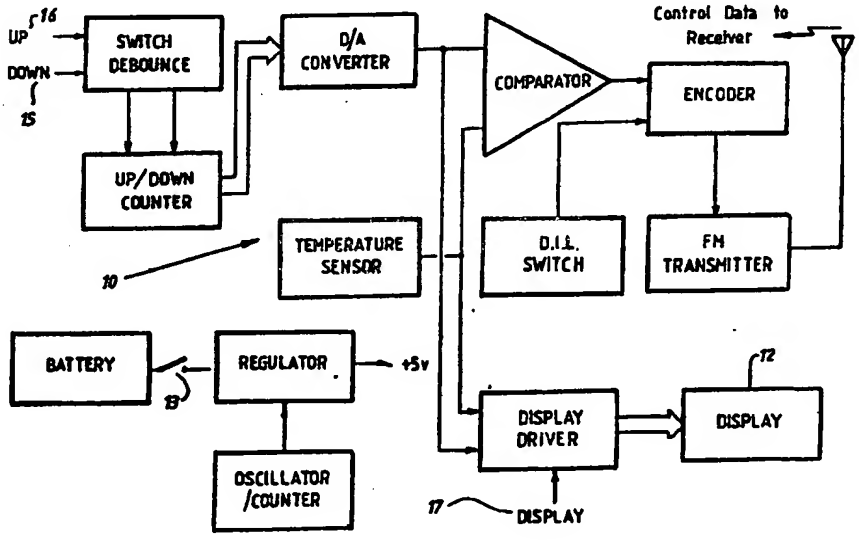

(57) Abstract

A control device for use with cooling and/or heating system which includes a control unit which is portable and which includes a temperature sensor, means whereby a required temperature can be set, means whereby a code can be generated when a change in state of the control unit is required and a transmitter which can be modulated by the code; a remote controller associated with the cooling and/or heating system which has a receiver to receive the coded signal and means whereby when the coded signal necessitates a change in status, this change is effected.

* See back of page

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CONTROL DEVICE

This invention relates to a control device and in particular to a control device which can be used with air-conditioning units or heating or cooling units.

Such devices are conventionally controlled by thermostats which are located in the area to be heated and/or cooled, and for convenience we shall generally refer to either or both of these as being air-conditioned. The thermostats have some form of temperature sensor and some form of switch device whereby in a particular range of temperatures a contact is made.

One particular form of device uses a bi-metallic spiral with which is associated a mercury switch with the spiral tending to become tighter or looser depending upon the temperature with the switch mounted at one end of the spiral so that the switch can make or break depending upon the condition of the spiral.

In another form of device, which is electronic, there can be a sensor and electronic circuitry which effectively measures the temperature and often these devices have an LCD display which displays the temperature and can, if required also display the temperature range or maximum or minimum temperature during which the device operates.

These devices use a form of electronic switch.

In either case, and in other forms of thermostat, the thermostat itself is wired to a control unit which is normally associated with the air-conditioner.

There are many applications when the wiring of the thermostat can be very time consuming.

For example the thermostat may need to be mounted on a wall and part of the plastering of the wall may need to be removed to run the wiring or, alternatively, the wall must be drilled into the wall cavity and the wire dropped to the floor of the cavity and passed through a hole formed in the stud or the like.

Whilst this is a relatively easy operation when a building is being built it is anything but that after completion of the building and, particularily where the wires must be located within plaster, the operation necessitates the wall or possibly the whole room being repainted.

Applicant manufactures an air-conditioning unit which is adapted to be relatively simply located into a furnace and the arrangement is such that the unit can be provided completely charged and ready to operate and needs only to be connected to a source of power to operate its compressor and to have the thermostat or thermostats wired thereto.

The location of a thermostat conventionally can be the major portion of the time in fitting the unit and can also be a substantial part of the cost of the whole unit if the thermostat is difficult to locate.

It is an object of the invention to provide a control means whereby the thermostatic control of air-conditioning and other units can readily be achieved.

The invention in its broadest sense comprises a control device which includes a thermostat, means associated with the thermostat so at least a required temperature can be selected, a transmitter the output of which is effected or modulated by the output of the thermostat and a remote controller which include a receiver associated with a controlled device which is actuated by a signal from the control device to start and or stop the operation of the controlled device.

The controlled device may be an air conditioning unit.

In order that the invention may be more readily understood we shall describe, in relation to the attached drawings particular forms of control devices made in accordance with the invention.

In these drawings:-

Figure 1 is a perspective view of a remote control unit showing the display and members controllable by a user;

Figure 2 is a block diagram of a first version of remote units;

Figure 3 is a similar diagram of a micro-processor controlled remote unit;

Figure 4 is a block diagram of a first form of receiver; and

Figure 5 is a block diagram of a micro-processor controlled receiver.

In this description the control system will be described as being comprised of the control unit 10 which is the thermostatic unit and which is located within the building being conditioned and the controller 20 which is associated with the air-conditioner.

The control unit is preferably portable but may be formed for wall or some other surface mounting and may comprise a box 11 enclosing the operative components of the unit.

The control unit 10 which is shown in Figure 1 has a box 11 which may be relatively small so as to be easily transportable and in one particular form could be of the order of 100mm by 150mm and 40mm thick. These are not considered to be restricting dimensions but give an indication that the unit can readily be hand held.

On its face the unit has a display 12 which may be a temperature display, and as will be described can be normally illuminated or not and may also have other display, such as BAT as shown on the Figure to indicate the battery status, with the display normally only being illuminated when the battery is low and it could also have an indication as to whether or not the temperature is out of range.

The unit is provided with an on/off switch 13 a set switch 14, set range buttons 15 and 16 and a display switch 17.

Simply for ease in understanding the following description of the embodiments the arrangement can be such that when the on/off switch 13 is off the device is quiescent, and no data is transmitted and the controller, which is associated with the cooling and/or heating unit, hereinafter called the conditioning unit, is in a condition where the unit or units are off.

When the unit 10 is on then it will be in a condition to send data to the controller to control the operation of the conditioning unit.

The display 12 may be illuminated at all times whilst the unit is on or could be controlled by display switch 17 which completes a circuit to cause the display to normally show the present ambient temperature.

The set switch 14 displays on the display 12 the temperature to which the device is presently set and the switches 15 and 16 can respectively raise or lower this temperature. Once the required temperature is set the device can either, after a certain time delay, cause the display to be extinguished or alternatively this can be effected by again pressing the set switch.

Figures 2 and 3 are two different modes of providing a unit in Figure 2 the unit 10 being done by a central processing unit.

Refering to Figure 2, there is shown in the lower portion of the Figure a power supply which has a battery, which may be a standard nine volt dry cell and a regulator which provides a regulated output.

In the upper portion of the block diagram there is shown a comparator having as one input a temperature sensor and the other a digital to analogue convertor which is controlled by the set switch 14 and the up and down switches 16 and 15.

These switches provide a required condition for an up/down counter the output of which is converted to an analogue signal which goes to the comparator.

If the comparison between the temperature sensor and the convertor shows that there should be some change in the state of the controlled device, that is the difference between the temperatures extend beyond the acceptable range then there is an output from the comparator which effects an encoder which in turn modulates an FM transmitter.

Under normal operating conditions the transmitter is normally operative at all times and the output from the encoder can modulate the transmitter with data to effect operation of the controller.

The transmitter can operate at any permisable and satisfactory frequency but in practice we have found a frequency of 40.7 MHz is satisfactory.

The converter and the temperature sensor are also in connection with a display driver which may be controlled by the display switch and from which either the ambient temperature or the set temperature can be displayed on the display 12.

The alternate unit 100 illustrated in Fig. 3 generally effects the same function as that of the unit 10 but it has a micro-processor controlling its general operation.

In general over view of the unit 100 the temperature sensor uses a constant current source which produces a linear relationship between current and temperature and is used to charge a capacitor which producers a linear ramp, the period of which is equal to one degree K. This ramp is applied to the input of the comparator and the comparator output changes when the ramp exceeds a predetermined voltage reference.

The change of state stops the count on a counter in the micro processor which operates at 32.768 Kilohertz and thus the value in the counter is equal to the reciprocal of the ambient temperature.

This can be converted directed to a format appropriate for driving the LCD display.

The micro processor is set up to permit operation in an acceptable range of temperatures, which in the practical unit can be between 0 degrees and 43 degrees C and the count value is checked to ensure that it is within this range.

The oscillator not only provides the base on which the temperature can be estimated but also provides a wake up signal for the micro processor at regular intervals, such as once every 120 seconds so that the ambient temperature is sampled.

Associated with the micro processor but not illustrated there can be an address generator which can comprise an 8 bit DIP switch which can provide some 255 address combination.

The LCD display and its driver are arranged to accept serial data from the micro processor in blocks of 36 bits, although this can be readily varied and the information for a full display can be provided in this number of bits.

The switch circuitry operates to initially cause a wake up on the micro processor and

to effect the display of the presently set temperature.

Operation of the switches 15 and 16 can vary this temperature.

The transmitter is continuously powered and essential by remains in an off state until an RF drive is applied.

In a preferred form, it is preferred to transmit the data in three groups of two identical bursts so as to minimise receive bit errors.

It will be seen that a substantial advantage of the unit of the invention over prior thermostats is that it measures ambient temperature at its own position. Normal single thermostat controls measure the temperature at a single position normally in relation to the air return and this can mean a used area is not at a desired temperature.

The controller 20 is illustrated in Figures 4 and 5 with, once again, the controller 20 of Figure 4 being effected by normal electronic circuitry and that 200 of Figure 5 by micro-processor control.

Again it will be seen that the controller has a power supply which can take its power from the normal power supply of the conditioner and has a voltage regulator to provide a regulated DC supply.

There is an FM receiver which is adapted to receive the signal transmitted by the unit 10 and a decoder which identifies the code with which the signal is modulated and forwards this to switching circuitary.

It will be appreciated there are normally four states which give three used conditions.

The first is when the heater is switched on and the cooler is switched off.

The second is where the cooler is switched on and the heater is switched off and the third is where both the heater and cooler are switched off. The condition where both the heater and the cooler are switched on would not normally be used although, in extremely humid areas there may be circumstances where such an arrangement

would be required and this can be effected, but it will be appreciated that the control unit 10 would need to be varied to cope with this.

The receiver can be arranged to normally accept the DATA from the unit 10 and if no DATA is detected then the conditioner will be switched off.

As long as an unmodulated carrier is detected then the present condition will be maintained and when a particular data train is received, the switching circuitry is caused to operate. That is if the unit has been switched off and is subsequently switched on but the temperature of the unit is within the required range then the conditioner will not be switched on until there is some variation.

The operation of the controller 200 of Figure 5 is substantially identical to that of the controller 20 of Figure 4.

The FM receiver can operate at 40.7 MHz and may have an amplifying stage and a mixer which includes a local oscillator to provide an intermediate frequency signal, which is preferably at 23 KHz.

The micro processor, which may be a 4 bit processor decodes all or part of the data, preferably a preamble bit of data from a group of transmitted data to check for error.

If there is any error then the processor returns to its initial condition and again rechecks for error.

When an acceptable decoded signal is obtained the processor can institute operation the switching circuitry in a matter previously described.

We have not, in this specification, described at length the particular form of coding to provide the data pulses nor have we discussed means whereby spirious pulses can be rejected.

It is possible, by use of the DIL switches in the encoder and the receiver or by use of the micro-processor to select pulse trains, if not unique to the particular unit, are unlikely to be repeated in a unit which is sufficiently near to interfere so that there is effective postive selection so that spurious signals cannot have an adverse effect

on the operation.

Of course if two or three units are to be placed in close proximity then the coding used will be selected to ensure that there is no confusion.

We have described herein a control unit in which the required operation is directly inputted by the user.

It is feasible to provide the unit as a programmed unit in which the unit comprises a timing circuit and the operation can be switched at predetermined times without any action by th user.

Such timers are known and can switch the unit on and off once or twice a dav at scheduled times or could switch the unit at different time at different days of the week.

The Claims defining the invention are as follows:

1. A control device which includes a thermostat, means associated with the thermostat so at least a required temperature can be selected, a transmitter the output of which is effected or modulated by the output of the thermostat and a remote controller which includes a receiver associated with the controlled device which is actuated by a signal from the control device to start and or stop the operation of the controlled device.

2. A control device as claimed in claim 1 wherein the thermostat, the temperature selecting means and the transmitter are in a single unit adapted to be located at the place at which the temperature is to be monitored.

3. A control device as claimed in claim 2 wherein the thermostat comprises a temperature sensor and comparator means whereby the output of the temperature sensor can be compared with the temperature as selected by the temperature selecting means and means whereby, if the condition of the control device is to be changed, then the transmitter is modulated in a predetermined manner which modulated signal, when received by the receiver, causes a change in the operating condition of the controlled device.

4. A control device as claimed in claim 2 or claim 3 wherein the unit includes a member operable by a user to effect the selection of a required temperature.

5. A control device as claimed in claim 4 wherein the unit has a display which can, when the user is effecting the selection of the required temperature indicate that the temperature being selected.

6. A control device as claimed in claim 5 wherein the display when the required temperature is not being selected is the temperature indicated by the temperature sensing means.

7. A control device as claimed in any one of the claims 4 to 6 wherein there are two members operable by a user one being to raise the selected temperature, the other to lower the selected temperature.

8. A control device as claimed in any of claims 4 to 7 wherein the switching on or off of the unit is achieved under program control and wherein the user can preset the required times and temperatures.

9. A control device as claimed in any one of claims 2 to 8 wherein the unit also includes means operable by the user whereby the output of the transmitter can be effected so that the control device can be cause to be operative or inoperative.

10. A control device as claimed in claim 9 wherein on the unit being switched off, and the transmitted data ceasing, the lack of data causes the controller to cause the controlled device to become inoperative.

11. A control device as claimed in any preceding claim wherein the tranmitter is an FM transmitter wherein the modulation is by bursts of data.

12. A control device as claimed in any preceding claim wherein the controled device is an air cooling unit.

13. A control device as claimed in claim 12 wherein the controlled device comprises both an air heating and an air cooling unit and wherein the output of the receiver can selectively control the operation of either of these units.

14. A control device as claimed in any preceding claim wherein the receiver is adapted to receive and demodulate the signal transmitted by the transmittor and use the demodulated signal to effect control of the controlled device.

15. A control device as claimed in claim 12 wherein the modulation is in the form of pulse trains which can indicate separate operations to be effected.

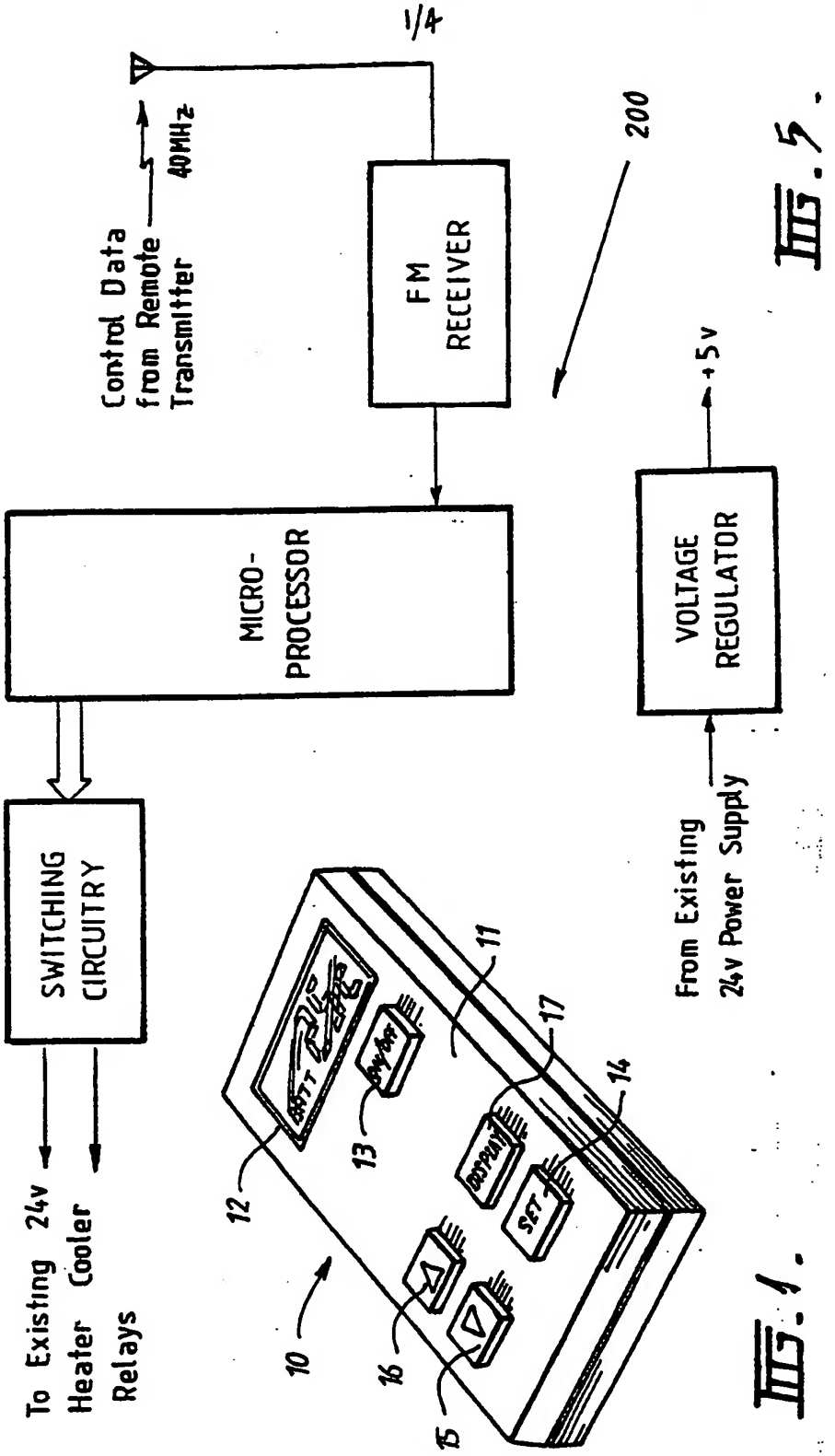
Control Data
from Remote
Transmitter
40MHz
FM
RECEIVER
200
+5v
MICRO-
PROCESSOR
VOLTAGE
REGULATOR
SWITCHING
CIRCUITRY
From Existing
24v Power Supply
To Existing 24v
Heater Cooler
Relays
10
11
12
13
14
15
16
17
SET

Fig. 5.

Fig. 1.

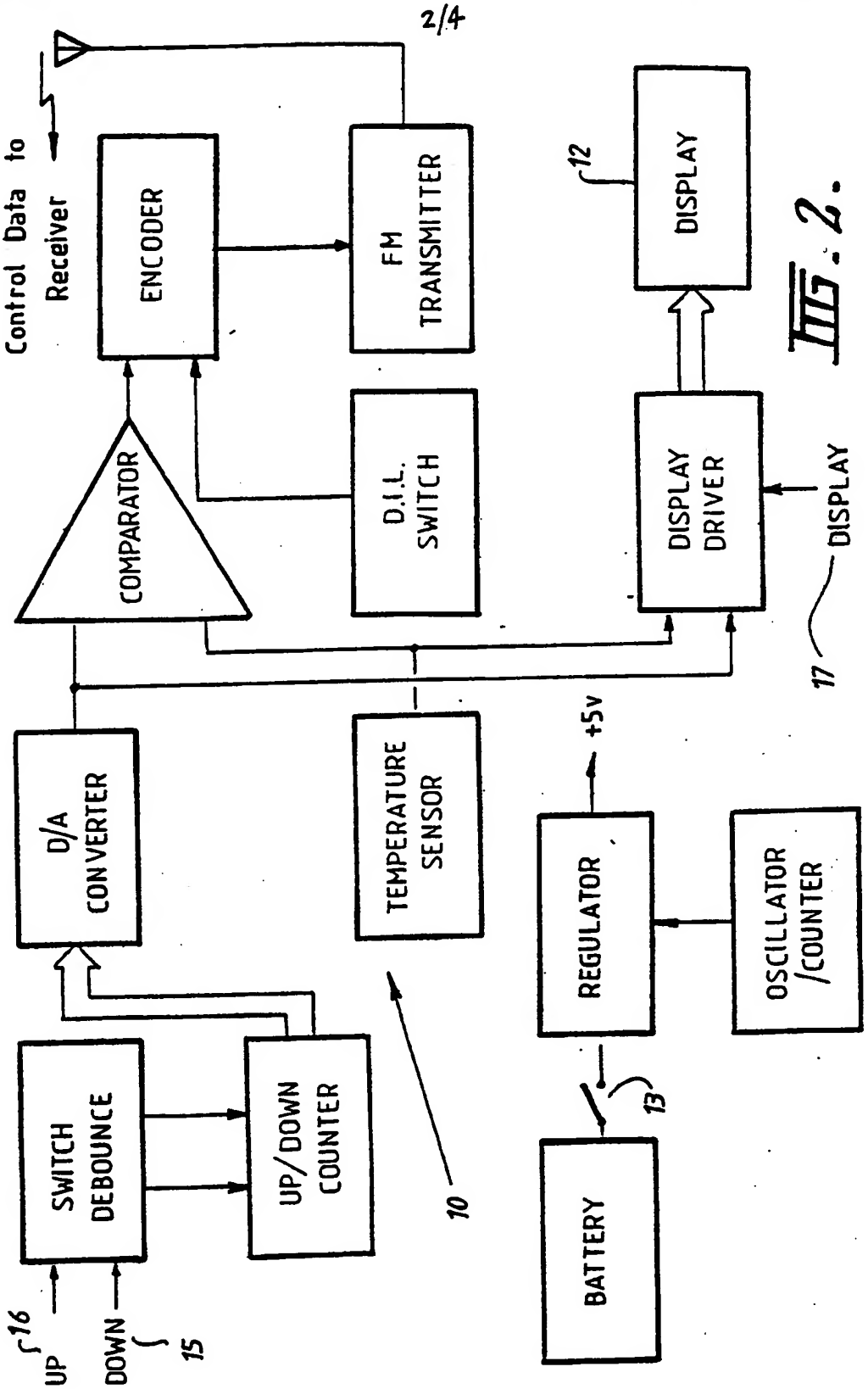
Control Data to Receiver
ENCODER
FM TRANSMITTER
12
DISPLAY
COMPARATOR
D.I.L. SWITCH
DISPLAY DRIVER
DISPLAY
17
D/A CONVERTER
TEMPERATURE SENSOR
+5v
REGULATOR
OSCILLATOR /COUNTER
SWITCH DEBOUNCE
UP/DOWN COUNTER
10
13
BATTERY
16
UP
DOWN
15

FIG. 2.

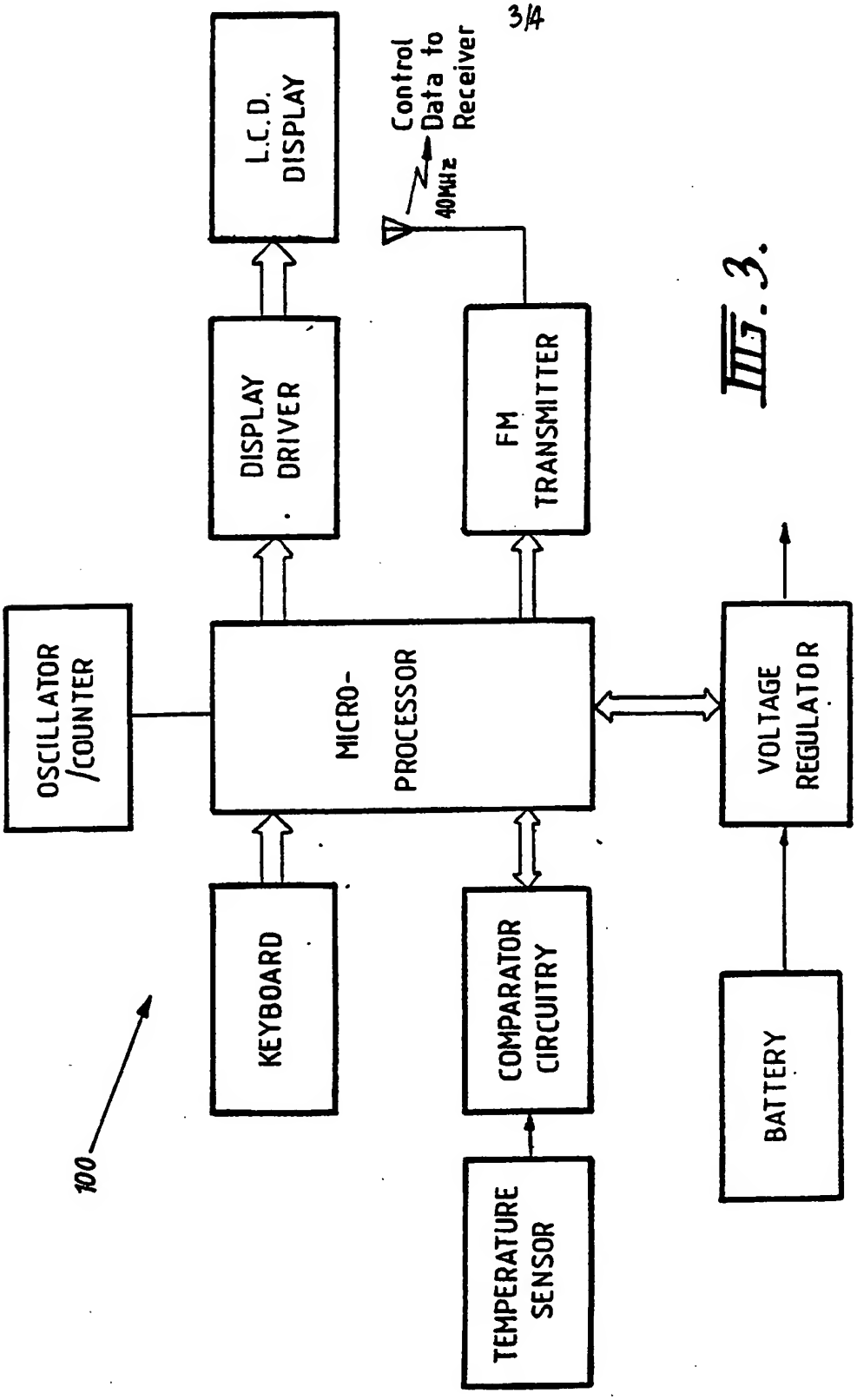
L.C.D. DISPLAY
Control Data to Receiver
40MHz
DISPLAY DRIVER
FM TRANSMITTER
OSCILLATOR /COUNTER
MICRO-PROCESSOR
VOLTAGE REGULATOR
KEYBOARD
COMPARATOR CIRCUITRY
BATTERY
TEMPERATURE SENSOR
100

Fig. 3.

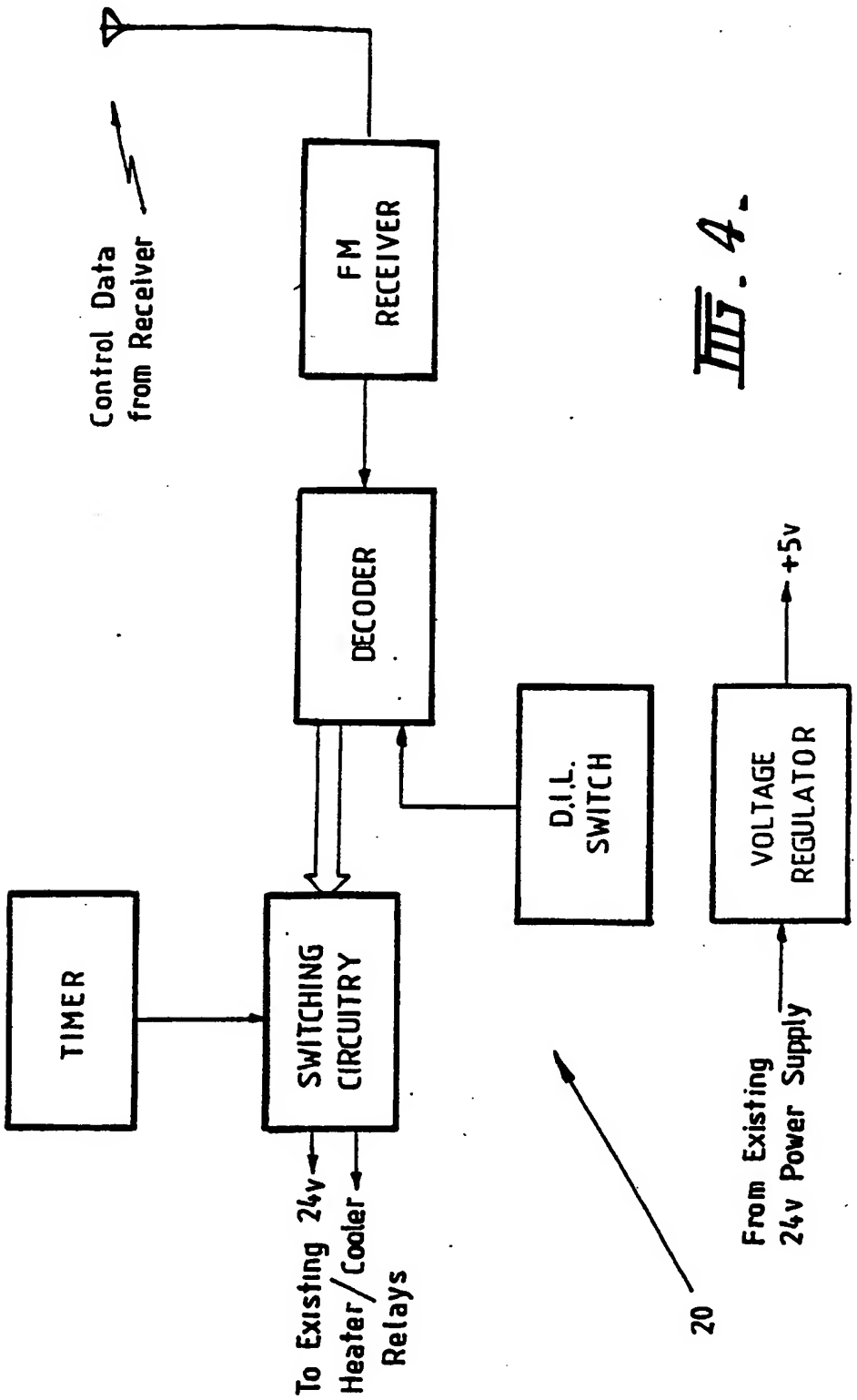
Control Data from Receiver
FM RECEIVER
DECODER
D.I.L. SWITCH
VOLTAGE REGULATOR
+5v
TIMER
SWITCHING CIRCUITRY
To Existing 24v Heater/Cooler Relays
From Existing 24v Power Supply
20

Fig. 4.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/AU 90/00192

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 6

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] F24F 11/00, F24F 11/053, G08C 17/00

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
IPC[5]	F24F 11/00, 11/053, G08C 17/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category*	Citation of Document, [11] with indication, where appropriate, of the relevant passages 12	Relevant to Claim No 13
X,P	Patent Abstract of Japan, M-891, page 9, JP,A, 63-24683 (SHIMIZU CORP) 11 August 1989 (11.08.89)	
X,P	Patent Abstract of Japan, E-869, page 36, JP,A, 63-79014 (FUJITSU GENERAL LTD) 6 October 1989 (06.10.89)	
X,P	Patent Abstract of Japan, E-849, page 167, JP,A, 63-38957 (MATSUSHITA SEIKO) 25 August 1989 (25.08.89)	
X	Patent Abstract of Japan, P-34, page 43, JP,A, 54-11186 (MATSUSHITA DENKI) 8 August 1980 (08.08.80)	
X	US,A, 4734871 (TSUNODA et al) 29 March 1988 (29.03.88)	(1)

(continued)

* Special categories of cited documents: 10

"A" document defining the general state of the art which is not considered to be of particular relevance

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
13 July 1990 (13.07.90)	24 July 1990
International Searching Authority	**Signature of Authorized Officer**
Australian Patent Office	R. HALLETT

Form PCT/ISA/210 (second sheet) (January 1985)

K 001080

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

X	AU,B, 495530 (14450/76) (B.E. KILE) 7 August 1978 (07.08.78)	(1)
X	AU,B, 574685 (29295/84) (PHILIPS GLOEILAMPENFABRIEKEN) 20 December 1984 (20.12.84)	

V. [ ] OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE 1

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.[ ] Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:

2.[ ] Claim numbers , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3.[ ] Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4 (a):

VI. [ ] OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING 2

This International Searching Authority found multiple inventions in this international application as follows:

1.[ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2.[ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3.[ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. [ ] As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

[ ] The additional search fees were accompanied by applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 90/00192

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members		
US 4734871	JP 61059144		
AU 14450/76	CA 1066360	GB 1554213	US 3937978
AU 29295/84	CA 1224527 NL 8302091	EP 129286	JP 60009293

END OF ANNEX